A FIELD STUDY OF SURFACE NUTRIENT ENRICHMENT IN THE CALIFORNIA CURRENT

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LONG-TERM GOALS

To use the phenomenon of surface enrichment of inorganic nutrients to better understand the cycling of nutrients and materials and physical mixing history in the surface layers of the ocean.

OBJECTIVES

The fall 1996 survey cruise of the California Cooperative Oceanic Fisheries Investigations (CalCOFI) was the foundation of a field program to describe in detail the spatial and temporal (diel) variability in the surface enrichment of phosphate, silicate, nitrate and nitrite (Haury et al., 1994, Haury and Shulenberger, In Press). The routine CalCOFI observations provided the environmental context within which the measurements of surface enrichment were made. Numerous ancillary programs provided additional contextual data (e.g. optics, phytoplankton pigments, and nutrient dynamics). The work provides the descriptive understanding of surface nutrient enrichment needed to formulate rational hypotheses on its formation and ecological significance.

APPROACH

The detailed description of surface nutrient enrichment augmented the standard CalCOFI sampling regime in three ways. (1) Increased vertical resolution: three extra depths in the upper 100 m were sampled at all stations; three special stations on Line 90 sampled 24 depths in the upper 125 m. (2) An AutoAnalyzer (HRAA) with enhanced (2-5x) detection, accuracy and precision limits measured nutrient concentrations on some stations of Line 93 and all stations of Line 90. (3) Time series measurements: at Station 93.50, a drogue was followed for 24 hr while taking 24-bottle CTD casts (0-125 m) at 4 hr intervals; at Station 90.120, a fixed geographic position was occupied for 24 hr with similar sampling.

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WORK COMPLETED

The work was carried out from 10 October to 2 November 1996 on CalCOFI cruise RR9610, the first scientific cruise of R/V Roger Revelle. A total of 85 CTD casts for nutrients was taken over the CalCOFI sampling grid, these included 14 HRAA time-series and 18 high vertical resolution casts. Data analyses are well underway.

RESULTS

Surface nutrient enrichment was detected at the following percentage of stations:

	Silicate	Phosphate	Nitrate	Nitrite
Regular AutoAnalyzer	38	44	15	4
High Resolution AA	84	76	49	9

On stations where both methods were used, the regular AA did not detect SNE at about one third of the stations where the HRAA detected it.

Preliminary analyses show that surface nutrient enrichment occurred occasionally in the near surface "well mixed layer" unassociated with density gradients. SNE occurred most frequently below density gradients, usually at the base of the mixed layer and well into the pycnocline. These results suggest that two separate processes (or sets of processes) form what we have called SNE: 1) true near surface enrichment, and 2) deeper subsurface nutrient depletion.

IMPACT

Surface nutrient enrichment appears to be a much more common feature of the upper layers of the ocean than previously believed. Elucidating the mechanisms forming surface enrichment and subsurface depletion will enhance understanding of nutrient cycling and the role of physics in mediating it. This will form the basis for characterizing and delineating the causes and ecological significance of SNE. Results from this study in the California Current will have application to oceanography in general, as surface nutrient enrichment occurs throughout the world ocean.

TRANSITIONS

This work uses detailed descriptive data to select, from the complex array of potential processes, a number of possible causes forming SNE. The reduced set of hypotheses can then form the basis of laboratory and field experiments carried out by specialists in other oceanographic sub-disciplines of oceanography (e.g., nutrient dynamics, plankton physiology, and physical oceanography) in order to understand SNE.

RELATED PROJECTS

Results from ancillary programs carried out on CalCOFI 9610 are invaluable in interpreting our SNE data. Collaborations are with:

Greg Mitchell (SIO): Detailed vertical bio-optical profiles; useful in hypothesis testing (e.g. photoinhibition, etc.)

Rick Reynolds (SIO postdoc): Fast Repetition Rate Fluorescence estimates of photosynthetic efficiency, etc. at several depths.

Ralf Goericke (SIO): Detailed pigment composition observations including vertical profiles (phytoplankton community structure).

Jackie Collier (Rensselaer Polytechnical Inst.): Phytoplankton community vertical structure using flow cytometry; profiles of ammonium and urea distributions and uptake rates.

REFERENCES

Haury, L.R., C.L. Fey and E. Shulenberger 1994. Surface Enrichment of Inorganic Nutrients in the North Pacific Ocean. Deep-Sea Research I, 41:1191-1205.

Haury, L. and E. Shulenberger In Press. Surface Nutrient Enrichment in the California Current off Southern California: Description and Possible Causes. Deep-Sea Research I.

The data from CalCOFI Cruise 9610 will be available on the Marine Life Research Group web site (http://www-mlrg.ucsd.edu) in late 1997 or early 1998.